Appendix 8

Soils, Agricultural Suitability and Land Capability

South East Open Cut Project
&
Modification to the
Existing ACP Consent

Department of Lands

Ashton Coal Operations Pty Limited

South East Open Cut

Soil, Land Capability and Agricultural Suitability Report

Version: Second Draft

Department of Lands

Soil Conservation Service

Scone Research Centre

30 July 2009

Summary

The Soil Conservation Service (Department of Lands) has prepared a Soil, Land Capability and Agricultural Suitability report for the Ashton Coal Operations South East Open Cut (SEOC) project. The report included the results of the field assessment of the soils and landforms. Soil test pits were excavated, the profile described, samples collected and laboratory analysis of the soil samples was completed. The studies were conducted in accordance with recognised guidelines and the information collected was utilised to determine the soil classification, land classification and suitability of topdressing materials.

Loamy Rudosols, Brown Sodosols, Grey Sodosols, Red Chromosols, Mottled-Sodic Red Chromosols and Sodic Bleached-Mottled Brown Chromosols soil types were identified on the SEOC project site. These soils were identified on the creek flats, terrace, footslopes, lower slopes, hillslopes and ridge lines. Soil properties identified across the area included moderately acidic to moderately alkaline pH, slight to moderate salinity and high dispersion was a common characteristic.

The rural land capability and agricultural land suitability were determined for the SEOC project site. The creek flats were mapped as rural land capability class II, the terraces and footslopes were mapped as rural land classification IV, the hillslopes were mapped as rural land class V, drainage lines and rocky hillcrests were mapped as rural class VI. The agricultural land classifications were based on the biophysical, social and economic characteristics. While, the creek flats were determined to be agricultural class 2 land (suitable for cultivation), the terraces and footslopes were determined to be class 3 (grazing land with some cultivation) and hillslopes and drainage lines were class 4 and class 5 (grazing land).

Generally, the soils were considered to be poorly suited for use as topdressing materials. A hardsetting soil surface, appeal structure, mottles, moderate salinity and high dispersion limit the suitability of the soil materials. However, the soil characteristics could be improved by treatment with the appropriate soil ameliorant.

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1. Introduction

1.1 Background

The Soil Conservation Service (Department of Lands) was engaged by Ashton Coal Operations Pty Limited (ACOL) to prepare a Soil, Land Capability and Agricultural Suitability Report for the South East Open Cut (SEOC) project. This report was prepared as part of the Environmental Assessment for the development of the SEOC project.

Ashton Coal Operations Pty Limited currently operates the Ashton Coal Project (ACP), which includes the North East Open Cut Coal Mine, Underground coal mine and Coal Handling and Preparation Plant, north-west of Singleton.

1.2 Scope of Report

This report provides soil classifications, rural land capability, agricultural suitability classifications and assessment of suitability of topdressing materials. The specific objectives of the study included:

- Description of representative soil types and classification according to the Australian Soil Classification and Northcote Key. The soil descriptions included: horizon names and depths, structure, coherence, coarse fragments, segregations and surface condition.

- Soil analysis for particle size, dispersion percentage (D%), Emerson aggregate test (EAT), electrical conductivity (EC) and pH.

- Determination of the rural land capability, agricultural land suitability classification and topdressing material suitability assessment.

1.3 Site Description

The Ashton Coal Operations SEOC project is located at Camberwell about 14 kilometres north-west of Singleton, adjacent to the New England Highway and Glennies Creek.

The site of proposed Ashton Coal Operations SEOC project is located within the central lowlands of the Hunter Valley with undulating low hills and with creek flats adjoining Glennies Creek. The underlying geology of the site includes Permian and Alluvial sediments (Kovac and Lawrie 1991).

The Roxburgh and Hunter soil landscapes have been mapped across the project site by Kovac and Lawrie (1991). The soil types recorded for the Roxburgh soil landscape are Lithosols, Brown Podzolic, Yellow Podzolic, Red Solodic and Yellow Soloths. The Hunter soil landscape is varied but includes Brown Clays, Black Earth as well as Alluvial Soils (loams and sands).

The SEOC site was primarily mapped as rural land class V – suitable for grazing with occasional cultivation based on the appropriate soil conservation practices. An area of Class II soil was identified adjacent to Glennies Creek (Soil Conservation Service, Camberwell Land Capability Series Sheet 9133). The agricultural land suitability classes mapped on the project site were class 1 (arable land with very good capability for agriculture), class 3 (lands not suitable for regular cultivation, but suited to improve pasture) and class 4 (poor grazing lands not suited for cultivation).

2. Methodology

2.1 Field Assessment

The assessment of the soil conditions of the proposed SEOC project site commenced with the interpretation of aerial photographs and topographic maps. Following the remote sensing, a series of observations were completed across the site to assess the soil types present, delineate the boundaries of the soil types and identify locations for the excavation of the soil test pits. The use of a hand auger, shovel and mattock allowed observations of the subsoil conditions at specific locations. The final stage of the field assessment was the excavation of soil test pits with an excavator, description of the soil profile and collection of soil samples for analysis. The soil test pits (Table 1) were located where the maximal development of each soil type was thought to occur and the co-ordinates (WGS84) of each soil test pit was recorded with a hand held Geographic Positioning System (GPS).

The observations and data collection were conducted in accordance with standard guidelines, to ensure validity of the records. The recognised guidelines utilised to provide the techniques for soil and land assessment in this study were McDonald *et al*. (1990), Milford *et al*. (2001) and Northcote (1984). New South Wales Soil Data System Cards were used to document the soil profile description. The soil profiles were classified according to the *Australian Soil Classification* (Isbell 2002) and the *Factual Key for the Recognition of Australian Soils* (Northcote 1984) (the full soil profile descriptions and classifications are provided in Appendix A).

2.2 Laboratory Analysis

Representative samples were selected and analysed by the Department of Lands, Soil Conservation Service Laboratory at the Scone Research Centre (Appendix B). The samples were analysed for: electrical conductivity (EC) and pH – 1:5 soil to water suspension; particle size analysis (clay, silt, fine sand, coarse sand and gravel); dispersion percentage (D%) and; Emerson aggregate test (EAT) and the interpretation of the test results was based on standard references (Charman and Murphy 2007, Hazelton and Murphy 2007).

The EC and pH were determined using a 1:5 soil to water suspension. A correction factor was used (based on the soil texture) to estimate the electrical conductivity of the saturation extract (ECe) (Taylor 1993) and hence the impact upon plant growth.

The particle size analysis was conducted by a hydrometer and sieving technique, to determine the percentage of clay, silt, fine (f) sand, coarse (c) sand and gravel. The dispersion percentage (D%) was also determined as a hydrometer analysis to assess the stability of the soil.

An EAT was conducted on selected soils to assess slaking and dispersion and hence the stability of the soil samples. Slaking describes the immediate break-up of dry soil aggregates into macroscopic fragments due to the swelling of the clay and entrapped air when placed in water (Emerson 2002). Dispersion refers to the clay released from the aggregate when placed in water (Emerson 2002). The Emerson aggregate test provides information on the slaking and dispersion of the soil and hence the stability of the sample can be assessed.

An assessment of the sodic soils was also undertaken across the site. The term sodic refers to a soil with an exchangeable sodium percentage (ESP) of 6 or greater (Isbell 2002). The exchangeable sodium percentage is the exchangeable sodium concentration expressed as a percentage of the cation exchange capacity (CEC). A characteristic of sodic soils is the tendency to disperse and hence the dispersion of the soil (as assessed with the Emerson Aggregate Test) was used as a surrogate for sodicity.

2.3 Rural Land Capability and Agricultural Suitability

The rural land capability mapping and the agricultural land assessment was conducted according to the recognised government guidelines (Department of Planning 1988, Emery undated and Hulme *et al*. 2002). The biophysical factors such as topography, soils and climate as well as social and economic factors were assessed to determine the land class.

2.4 Suitability of Topdressing Material

The assessment of the soil materials was based on the procedure described by Elliot and Reynolds (2007). The procedure includes assessment of soil profile characteristics and laboratory analysis and requires consideration of soil structure, coherence, mottles, force to disrupt peds, texture, pH and salinity.

3. Soils

3.1 Rudosols

Defined by Isbell (2003), as soils of negligible or rudimentary pedological organisation (that is, young soils where there has been little modification of the parent sediments), Rudosols describe the sandy loam and loamy sands identified adjacent to Glennies Creek. Soil test pit (TP) 81 was excavated in the alluvial flats adjacent to Glennies Creek as a representation of the Loamy Rudosols within this area. The soil profile was found to consist of a very dark greyish brown and slightly acidic (pH 6.3) sandy loam topsoil layer recorded to a depth of 1.2 m. The underlying topsoil layer was dark brown, loamy sand with a neutral pH (7.0) to a depth of 3 m.

The soil salinity, determined by laboratory testing of the EC, was estimated to be low throughout the soil profile (Table 2). The samples of the Loamy Rudosols (TP 81) were prone to slake but exhibited only slight dispersion. These results are indicative of samples that may be prone to set hard if cultivated when wet.

3.2 Chromosols

Conceptually, the term Chromosols provides for soils with a strong texture contrast (clear or abrupt boundary between A and B horizon) and where the subsoils are not strongly acidic and are not sodic (Isbell 2003). The Chromosol soils observed on the SEOC project site included Red Chromosols and Mottled-Sodic Red Chromosols –TP 74 and TP 85 were examples of the Red Chromosols. The second distinct group of Chromosol soils were recorded as Sodic Bleached-Mottled Brown Chromosols –TP 75 and TP 88 were examples of the Sodic Bleached-Mottled Brown Chromosols. The Sodic Chromosol soils (an apparent contradiction in terms) were described on the basis that the field assessment identified sites with dispersive (ie. sodic) lower subsoil layers below the non-dispersive upper subsoil. It should also be noted that rock outcrops were also consistent within the area of the Chromosol soil group and that limited areas of Tenosols (an A horizon directly overlying rock) were also recorded.

Table 1. Soil test pit classifications and locations.

Soil test pit	Description	GPS Coordinates	
		Easting	Northing
TP 74	Mottled-Sodic Red Chromosol	320698	6404570
TP 75	Sodic Bleached-Mottled Brown Chromosol	320715	6404555
TP 76	Brown Sodosol	320593	6404801
TP 77	Brown Sodosol	319881	6404469
TP 78	Brown Sodosol	320025	6404559
TP 79	Grey Sodosol	320008	6404830
TP 80	Grey Sodosol	320096	6404555
TP 81	Loamy Rudosol	319506	6404492
TP 82	Grey Sodosol	319884	6403698
TP 84	Brown Sodosol	320186	6404107
TP 85	Mottled-Sodic Red Chromosol	320325	6404178
TP 88	Sodic Bleached-Mottled Brown Chromosol	321280	6403444
TP 89	Brown Sodosol	319659	6403676
TP 90	Brown Sodosol	320066	6403191

Table 2. Summary of soil test results (Soil test report SCO08/400).

Sample Id	Salinity		pH	
	(dS/m)	Rating		Rating
TP 74/1 0-0.12 m	0.03	Low	5.7	Moderately acidic
TP 74/2 0.12-0.40 m	0.12	Low	5.6	Moderately acidic
TP 79/1 0.0-0.07 m	0.04	Low	5.6	Moderately acidic
TP 79/3 0.14-0.83 m	0.45	Slight	8.4	Mod. alkaline
TP 80/1 0-0.08 m	0.04	Low	6.0	Moderately acidic
TP 80/3 0.16-0.60 m	0.35	Slight	7.6	Mildly alkaline
TP 80/4 0.60-1.20 m	0.64	Moderate	5.6	Moderately acidic
TP 81/1 0-0.20 m	0.02	Low	6.3	Slight acidic
TP 81/2 0.20-1.20 m	0.05	Low	7.3	Neutral
TP 81/3 1.20-2.20 m	0.10	Low	7.0	Neutral
TP 88/1 0-0.24 m	<0.01	Low	5.9	Moderately acidic
TP 88/3 0.38-0.65 m	0.03	Low	6.8	Neutral
TP 89/1 0-0.45 m	0.04	Low	6.9	Neutral
TP 89/2 0.45-0.90 m	0.10	Low	7.6	Mildly alkaline
TP 89/5 1.50- 2.50 m	0.19	Low	7.2	Neutral
TP 90/1 0-0.15 m	0.02	Low	6.3	Slight acidic
TP 90/3 0.30-0.60 m	0.19	Low	8.6	Strongly alkaline

The Red Chromosol soils (TP 74) consisted of moderately acidic (pH 5.7), reddish brown, clay loam topsoil to a depth of about 0.12 m. Typically, underlying the topsoil was strongly structured but moderately acidic (pH 5.6), yellowish red, medium clay. At some locations pale red or yellowish, mottled and dispersive clay layers were observed above the parent rock (and therefore classified as Sodic Red Chromosol).

A moderately acidic, dark greyish brown, sandy clay loam A1 horizon and a pale brown bleached A2 horizon typically formed the topsoil of the Bleached-Mottled Brown Chromosol. The subsoil was yellowish brown, medium clay with orange and grey mottles, characteristically indicative of impeded drainage through the subsoil.

The laboratory analysis (of samples TP 74/1, TP 74/2, TP 88/1 and TP 88/3) found low salinity for all of the Chromosol samples tested (Table 2). The laboratory analysis (EAT) also identified Chromosol topsoil samples (TP 74/1 and TP 88/1) prone to slake but with slight dispersion when reworked, which is consistent with the hardsetting soil surface and massive structure of the A horizon observed in the field. The Chromosol subsoil samples (TP 74/2 and TP 88/3) were also prone to slake and disperse when reworked. However, the field assessment did identify dispersive (hence also considered to be sodic) samples of the lower subsoil layers.

Plate 1. Soil test pit 74.

Mottled-Sodic Red Chromosol (upper slope)

A - reddish brown clay loam

B - yellowish red medium clay with faint grey mottles at depth

C - ironstone, weathered fine sandstone or siltstone

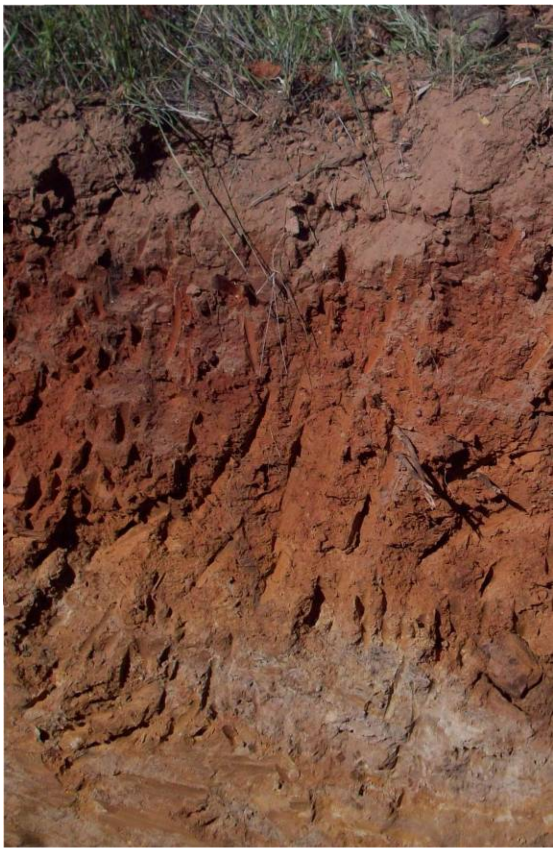

Plate 2. Soil test pit 88.

Bleached-Mottled Brown Chromosol (upper slope)

A1 - dark greyish brown sandy clay loam

A1 - light brownish grey light sandy clay loam

B2 - yellowish brown medium heavy clay

C - weathered sandstone (coarse)

3.3 Sodosols

Sodosols are defined by Isbell (2003) as soils with a clear or abrupt textural change and, in which the B2 horizon (subsoil) is sodic but not strongly acid. Grey Sodosols and Brown Sodosols were found on the midslopes, lower slopes, footslopes and terrace and hence, Sodosols were the major soil type identified across the SEOC project area.. The soil test pits TP 76, TP 77, TP 78, TP 84, TP 89 and TP 90 were all classified as Brown Sodosols and TP 79, TP 80 and TP 82 were classified as Grey Sodosols (Table 1).

The typical Grey and Brown Sodosol identified on the midslopes, lower slopes and footslopes was found to consist of a massive and hard setting, very dark brown, loam topsoil (A1 horizon). A characteristic of these soils was the presence of a greyish brown, fine sandy clay loam, bleached A2 horizon. Underneath the topsoil layers, the subsoil (B horizon) typically observed was a yellowish brown, medium clay often with a strong prismatic structure. Several layers of clay, both yellowish brown or yellowish red, may be present overlying the fine sandstone or siltstone.

A clear distinction was observed between the Brown Sodosols of the midslopes, lower slopes and footslopes (transportational and depositional landforms of the Permian sediments) and the Brown Sodosol samples collected from the creek terrace (thought to be part of the Hunter soil landscape). The bleached A2 horizon, a characteristic of the soil profiles located on the slopes, was absent in the soil test pits on the creek terrace. Furthermore, a strong prismatic structure was recorded in the top of the subsoil (B21 horizon) of the lower slopes, but was not observed within the test pits of the creek terrace.

Plate 3. Soil test pit 80.

Grey Sodosol (midslope)

A1 - dark brown clay loam

A2 - greyish brown silt clay loam

B21 - greyish brown heavy clay

B22 - yellowish red medium clay

C - red and white mottled siltstone

Plate 4. Soil test pit 89.

Brown Sodosol (creek terrace)

A - dark brown loam

B - dark brown medium clay overlying brown clay loam; light clay and sandy clay loam

The laboratory analysis of the Brown and Grey Sodosol samples, located on the slopes, (TP 79/1, TP79/3, TP 80/1, TP 80/3, TP 90/1 and TP 90/3) reveals that while the topsoils (A horizons) were moderately acidic, slightly acidic or of neutral pH and with low salinity, the subsoils were in contrast, typically both moderately alkaline and moderately saline (Table 2). This salinity level recorded for the subsoil indicates that the growth of some plants species may be limited (field assessment also found moderately saline subsoil samples). Interestingly, the analysis of the TP 89/1, TP 89/2 and TP89/5 samples (Brown Sodosol thought to be located in the creek terrace landscape) indicates that the pH was neutral (pH 6.9, 7.6 and 7.2) and salinity was low throughout the soil profile (Table 2). The laboratory determination of the slaking and dispersion characteristics (EAT) for the Sodosol soils (TP 79/1, TP79/3, TP 80/1, TP 80/3, TP 89/1, TP 89/2, TP 89/5, TP 90/1 and TP 90/3) was consistent with the field characteristics observed. The topsoils were prone to slake but exhibited only slight dispersion, which reflects the surface crusting, hardsetting and massive structure of the A horizons. Furthermore, the high dispersion recorded for the B horizon was indicative of the tendency for poor drainage, poor physical conditions and susceptibility to erosion in the subsoils.

4. Rural Land Capability and Agricultural Suitability

The process for the assessment and classification and subsequent management of rural land may be based on the two recognised techniques currently used to assess rural land in New South Wales – rural land capability mapping (Emery undated) and agricultural land classification (Department of Planning 1988). The primary objective of rural land capability mapping is for the protection of the soil and minimisation of soil degradation, particularly soil erosion, based on the inherent physical characteristics of the land. In contrast, the agricultural land classification was developed "specifically to meet the objectives of the Environmental Planning and Assessment Act 1979" and is based on evaluation of the social and economic factors as well as the biophysical factors of the land (Hulme *et al*. 2002).

Mapping of the rural land capability and agricultural land classification has been conducted by government agencies across areas of New South Wales with these maps generally available at a scale of 1:100,000. At this scale, the minimum mappable area is 40 hectares (as reported by Hulme *et* *al*. 2002). Therefore, for the area of the proposed SEOC project, 1:100,000 scale maps are unlikely to provide the detail required for a reliable assessment of the land capability of this site.

4.1 Rural Land Capability Mapping

Rural land capability (Emery undated) is a standard eight class system, broadly grouped as; land suitable for cultivation, land suitable for grazing and land unsuitable for agriculture (Table 3). The land categories are further subdivided depending upon the soil conservation practices thought to be required to maintain soil condition.

Table 3. Rural land capability classes (Emery undated).

	Classification and soil conservation practices
Land Capability Class I	Suitable for regular cultivation – no special soil conservation works or practices.
Land Capability Class II	Suitable for regular cultivation – soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation.
Land Capability Class III	Suitable for regular cultivation – structural soil conservation works such as graded banks, waterways and diversion banks, together with soil conservation practices such as conservation tillage and adequate crop rotation.
Land Capability Class IV	Suitable for grazing with occasional cultivation – soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for the establishment or re-establishment of permanent pasture.
Land Capability Class V	Suitable for grazing with occasional cultivation – structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV.
Land Capability Class VI	Suitable for grazing with no cultivation – soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. May include some isolated structural works.
Land Capability Class VII	Land best protected by green timber.
Land Capability Class VIII	Cliffs, lakes or swamps and other lands unsuitable for agricultural and pastoral production.

The Soil Conservation Service Camberwell Land Capability Map (Sheet 9133, 1:100,000) shows the proposed SEOC project site as rural land class V (suitable for grazing with occasional cultivation with structural soil conservation works) on the hillslopes and as rural land class II (suitable for regular cultivation with soil conservation practices) on the creek flats, terrace and footslopes.

Based on the detailed site and soil assessment undertaken, rural land capability class II (suitable for regular cultivation with soil conservation practices such as direct drill, minimum tillage and rotation with permanent pastures) was considered to be appropriate for the light textured creek flats. However, the hardsetting, and in places poached, soil surface, massive structured topsoil and highly dispersive subsoil of the terraces and footslopes suggests that rural land classification IV (suitable for grazing with occasional cultivation) would be applicable for the terraces and footslopes. The appropriate management practices would include grazing management, application of fertiliser as well as conservation tillage, direct drill and crop rotation. The identification of a hardset poached soil surface condition of some paddocks with the terrace landforms reinforces the requirement for soil conservation practices to minimise soil degradation.

With the exception of the rocky areas and drainage lines, and consistent with the Camberwell Land Capability Map (Soil Conservation Service), the hillslopes were mapped as rural land class V (suitable for grazing and occasional cultivation with structural soil conservation works). The minor drainage lines and rocky hillcrests were mapped as rural class VI (suitable for grazing with no cultivation). Well defined, incised drainage channels of fifth order or greater would be rural land class VIII.

4.2 Agricultural Land Classification Assessment

The agricultural land classification (Table 4) was specifically developed for land use planning, has six classes (Hulme *et al*. 2002) and is based on biophysical factors, social factors and economic factors.

Data provide by the NSW Department of Primary Industries shows the creek flats, terraces and footslopes as agricultural land class 1 (arable land with very good capability for agriculture). The hillslopes were either agricultural land class 3 (lands not suitable for regular cultivation, but suited to improve pasture) or agricultural land class 4 (poor grazing lands not suited for cultivation).

More detailed survey and assessment suggests that: agricultural land class 2 (arable land suitable for regular cultivation) would be appropriate for the light textured creek flats; the hardsetting and dispersive terrace and footsopes could be class 3 (rotation of pasture and cropping); hillslopes mapped as class 4 (grazing but no cultivation) and; class 5 (light grazing) for the timbered slopes and major drainage lines. The requirement for the construction of structural soil conservation works to minimise erosion with cultivation of hillslopes would make cultivation of these areas uneconomic and thus the recommendation of class 4 agricultural land.

Table 4. Agricultural land classification (Hulme *et al*. 2002).

	Description
Class 1	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.
Class 2	Arable land suitable for regular cultivation for crops, but not suited to continuous cultivation.
Class 3	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture.
Class 4	Land suitable for grazing but not cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques.
Class 5	Land unsuitable for agriculture or at best suited only to light grazing.
Specialist class	Land which, because of a combination of soil, climate and other features is well suited to intensive production of a crop or a narrow range of crops.

5. Topdressing Material

Soil characteristics can influence the soil suitability for rehabilitation and the successful establishment of vegetation. As discussed by Handreck and Black (1989) and Elliott and Reynolds (2007) there is no substitute for natural topsoil for successful mine rehabilitation. Although organic matter is a key constituent, soil contains minerals formed from long periods of weathering that are not present in freshly crushed rock. However, natural topsoil is not always available for revegetation and alternative topdressing material must be sought.

Elliott and Reynolds (2007) describe a procedure for the selection of material for use in topdressing of disturbed areas. The procedure is based on soil profile assessment and laboratory analysis and allows for the soil samples to be classified as:

- suitable for general use
- restricted use requiring amelioration
- not suitable.

Factors including the soil structure, coherence, mottles, force to disrupt peds, texture, pH and salinity were taken into consideration for the assessment of the soil suitability for use as topdressing material.

5.1 Red Chromosols

Based on the assessment of the topsoil (A horizon) characteristics, the Red Chromosol topsoil was thought to be suitable for use as topdressing material. Therefore, is it suggested that the topsoil be stripped to a depth of 0.1 m for use in rehabilitation activities. The strongly structured red clay subsoil (B horizon) observed for the Red Chromosol soil was classified following the guidelines of Elliott and Reynolds (2007) and also thought to be suitable for use as topdressing materials. The recommended subsoil stripping depth is 0.3 m. Below this depth the dispersion of the soil increases and hence the deeper subsoil was therefore, less suited for use as topdressing material and would require amelioration.

5.2 Brown Chromosols

The Brown Chromosol topsoil (A horizon) may also be utilised as topdressing materials to a depth of 0.2 m. As the soils may be prone to set hard, the topsoil should be managed to minimise degradation of soil structure. Due to the presence of soil mottles, the Brown Chromosol subsoil was classified (in accordance with the guidelines of Elliott and Reynolds 2007) as restricted use topdressing materials, nevertheless it is suggested that the subsoil be stripped to a depth of 0.3 m for use. The deeper subsoil should be avoided as the soil may be highly dispersible and hence prone to erosion.

Stripping of topsoil should be avoided in the areas where the sandstone outcrops.

5.3 Sodosols

Within the SEOC project area identified as Sodosol soils the topsoil may provide material for use as topdressing materials to an average estimated depth of 0.3 m. Due to the hardsetting nature and massive structure observed, management practices should be adopted to minimise soil degradation. The Sodosols subsoil were considered to be poorly suited as topdressing materials (due to the dispersion, mottles and poor structure) and should only be used with a high level of treatment required. Ameliorants required for treatment would include high rates of gypsum, organic matter and fertiliser. Due to the moderate salinity observed, use of Sodosol subsoil below a depth of 0.5 m for topdressing material should be avoided. Furthermore, the use of soil with high proportion of gravel for topdressing should be avoided.

5.4 Loamy Rudosols

The Loam Rudosols could be used for topdressing, but use of the apedal and sandy subsoils for topdressing materials is not suggested.

5.5 Topdressing Volumes

Table 5 shows estimates of the available topdressing material quantities.

The open cut and out of pit emplacement will disturb approximately 280-300ha that will result a new surface area to be rehabilitated of approximately 300ha.

There is almost 700,000m^3 of topsoil considered suitable for topdressing, with a further 130,000m^3 that can be ameiliorated. This will provide topsoil depths considered sufficient to adequately prepare the site for revegetation, especially with the use of imported organic matter as currently used at the existing ACP open cut.

Table 5. Soil suitability for use as topdressing materials (following the guidelines of Elliott and Reynolds 2007).

Soil type / horizon	Top dressing material	Stripping		
		Depth (m)	Area (ha)	Volume (m^3)
Red Chromosols				
A	Suitable	0.1	13.02	13,020
B	Suitable	0.3		39,060
Brown Chromosols				
A	Suitable	0.2	43.72	87,440
B	Suitable with amelioration	0.3		131,160
Brown Grey Sodosols				
A	Suitable	0.2	209.54	419,080
B	Poor suitability	0.3		628,620
Loamy Rudosols				
A	Suitable	1	13.26	132,600
B	Mostly unsuitable	NA		NA

6. Soil Management

Soil management strategies can be adopted to preserve the soil condition and minimise soil degradation. The identification and quantification of the soil resource available for the SEOC project is considered to be the first step towards sustainable soil management and has been undertaken in this study. During the implementation of the SEOC project, the soil may be managed with optimisation of soil recovery, stripping and stockpiling procedures to minimise the degradation of the resource. Effective utilisation of the available soil as well as amendment of inherit poor soil conditions to improve plant growth would then be the next step along the path to successful soil management underpinning revegetation of the project site. The current study provides information as the basis for future soil management, but strategic assessment of the final land surface should be conducted to provide additional data for site specific management details.

6.1 Soil Limitations

Soil limitations were identified across the SEOC project site that may limit plant growth and thus revegetation and rehabilitation. Limitations to plant growth identified included a hard setting soil surface, poor soil structure, slaking, dispersion, and moderate salinity. Some of the soils observed also exhibited characteristics of poor drainage (most significantly the Sodosol soils). Treatment of the soil these inherit soil characteristics should improve the soil conditions for plant growth.

The immediate break-up of soil into microscopic fragments when place in water, referred to as slaking, was consistent characteristic of the topsoil observed at the site. The hardsetting soil surface observed is also a common characteristic of slaking soils. Hardsetting soil is problematic for revegetation as seed germination and establishment is usually decreased. Slaking is recognised as being indicative of less than optimal soil organic matter and as such, the recognised treatment is the application of organic matter and mulch. The application of mulch also serves to protect the soil surface from the effects of raindrop impact. Treatment of the soils with organic matter mulch during revegetation is suggested for all soils across the project area.

Spontaneous and high soil dispersion, associated with high levels of exchangeable sodium and low levels of exchangeable calcium, is a wide spread inherit characteristic of soils through the central lowlands of the Hunter Valley and also within some soils of the SEOC project site. The term sodic is used to describe soils with high a exchangeable sodium, which usually occurs in conjunction and low exchangeable calcium. The poor soil structure and mottled colours is, in part, the physical expression of the inherit chemical imbalance between sodium and calcium. Poor drainage and also water logging are also associated high sodium and poor structure.

Treatment of sodic or highly dispersive soils is widely adopted agricultural practice with the addition of calcium to balance the sodium levels suggested. The most common forms of calcium utilised for the treatment of dispersive soils are agricultural lime and natural gypsum products. The soil pH provides basis for selection of either agricultural lime or gypsum and for slightly acidic to alkaline soil such as recorded for the SEOC project site gypsum is suggested as the most effective ameliorant. The application of organic matter suggest recommended for treatment of soil slaking would also be expected to provide benefits for the management of sodic or dispersive soils.

Table 6. Soil amelioration required for soil management.

Soil type / horizon	Limitations	Soil ameliorants
Red Chromosols		
A	Hardsetting Low nutrients	Organic matter mulch Fertiliser
B	Slaking Low fertility	Organic matter mulch Fertiliser
Brown Chromosols		
A	Hardsetting Low nutrients	Organic matter mulch Fertiliser
B	Poor structure Mottles Dispersion	Organic matter mulch Fertiliser r Gypsum
Sodosols		
A	Hardsetting Low nutrients	Organic matter mulch Nitrogen and phosphorus fertiliser
B	Poor structure, mottles Low nutrients Dispersion	Organic matter mulch Fertiliser Gypsum
B (deep subsoil)	Poor structure, mottles Low nutrients Dispersion Salinity	Not suitable – isolate from plant roots
Loamy Rudosol		
A	Sandy texture Low nutrients	Organic matter mulch Fertiliser
B	Sandy texture	Not suitable – isolate from plant roots

Natural soils are recognised as having low plant nutrients and it follows that the application fertilisers to improve soil nutrient deficiencies is adopted not only for soil rehabilitation but also for agricultural practice. The application of fertilisers (such as nitrogen and phosphorus) is thought to be of critical importance to allow adequate plant growth that may provide soil ground cover to protect the soil surface from erosion but also allows the build up of soil organic mater, and carbon and biological activity.

6.2 Soil Salinity

There were no saline soil scalds (or saline topsoil layers) observed on the SEOC project site. Moderately saline subsoil (at depths below about 0.6 m) were however, recorded in the soils on the lower slopes and foot slopes (Sodosols). . Although, traditional practice for treatment of salines soil includes amelioration with gypsum and application of organic matter mulch, due to the difficulties associated with the treatment of saline soils, the moderately saline subsoil material should be identified during the stripping process and isolated and buried to isolate from plant roots.

6.3 Soil Handling Requirements

The soil should be stripped and handled to minimise the degradation of the soil structure as well as preserve biological activity within the soil material. Ideally, the soil should be stripped and handled when in a moist state and not when either dry or wet. A stockpile height of less than 2 m with maximum batter grades of 2:1(horizontal: vertical) is also desirable. Material stripped for use as topsoil/topdressing material or as subsurface material should be stockpiled separately for reuse. If the soil is to be stockpiled for a period of time, the stock pile should be revegetated. Furthermore, assessment of weed infestations is also suggested prior to stripping and spreading.

7. Conclusions

The major soil types identified on the SEOC project site were Brown and Grey Sodosols. Sodosols were identified on the midslope, lower slope, footslope and terrace landforms. On the upper slopes and ridge lines, Red and Brown Chromosols, that may be sodic at depth, were identified. Both Chromosols and Sodosols consist of sandy loam-clay loam topsoil with a clear or abrupt change to light clay-medium clay subsoil. The soils tended to be moderately acidic, slightly acidic, neutral or alkaline and some deeper subsoils were slightly to moderately saline. Highly dispersive deep subsoil tended to be a consistent observation across the site. The alluvial soils of the creek flats consisted of horizons of loam, sandy loam or loamy sand and classified as Loamy Rudosols. The soil types observed across the project site were considered to be generally consistent with the existing soil data.

The rural land capability and agricultural land suitability were determined for the SEOC project site. The site and soil assessment conducted indicated that the creek flats were rural land capability class II, terraces and footslopes rural land classification IV, the hillslopes were mapped as rural land class V, drainage lines and rocky hillcrests were mapped as rural class VI (suitable for grazing with no cultivation). The agricultural land classifications were determined to be class 2 on the creek flats and class 3 on the terrace and footsopes. While the hillslopes were agricultural land class 4 hillslopes, the timbered slopes and major drainage lines were agricultural land class 5.

Although limited areas of strongly structure red clays were assessed as suitable for topdressing material, the massive and hardsetting surface soils and the dispersion and salinity of the yellowish brown subsoil across the main area of the site affect the suitability of the soils for topdressing materials. Treatment of the soils with organic matter, gypsum and fertiliser as required would improve the suitability of the soils for topdressing. However, use of the moderately saline subsoils should be avoided.

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Appendix A – Soil profile descriptions

Test Pit 74 Landform: Upper slope (4%) westerly aspect
Soil classification: Mottled-Sodic Red Chromosol (Dr3.31)
Location: NE site, near highway (320698E 6404570N)
Surface condition: surface crust, hard set, 80% groundcover, volun./ native pasture

Layer 1 – A (0.0-0.12) Reddish brown (5YR 4/3) clay loam; massive, earthy fabric; moderately weak and brittle (dry) consistence; angular and angular tabular (2-6 mm & 6-20 mm) gravel common; (a sporadically bleached A2 horizon may also be present in some locations) abrupt change to

Layer 2 – (0.12-0.40) Yellowish red (5YR 4/6) medium clay; strong pedality with polyhedral (20-50 mm) peds; very firm and crumbly (dry) consistence; very few angular and angular tabular (2-6 mm) coarse fragments; clear change to

Layer 3 – B22 (0.40-0.60) Yellowish red (5YR 5/8) medium clay with faint grey mottles (2-10%); moderate pedality, 20-50 mm polyhedral peds, rough-faced fabric; moderately firm and labile (moderately moist) consistence; very few coarse fragments;

Layer 4 – C (0.60-0.70 m) weathered ironstone

Layer 5 – R (0.70-) weathered fine sandstone/siltstone, bedrock reached, end of excavation.

Test Pit 75 Landform: Upper slope (5%) westerly aspect
Soil classification: Sodic Bleached-Mottled Brown Chromosol (Dy3.41)
Location: NE site, near highway (320715E 6404555N)
Surface condition: firm, 90% groundcover:, volun./native pasture

Layer 1 – A1 (0.0-0.20 m) Brown (7.5YR 4/3) sandy loam; massive, earthy fabric, moderately weak and brittle (dry) consistence; many roots; field pH 6.0; clear change to

Layer 2 – Layer 2 A2 (0.20-0.30 m) Light brown (7.5YR 6/3) sandy loam; massive, earthy fabric; moderately weak and brittle (dry) consistence; few fine gravel and gravel (sub-angular and sub-angular tabular); roots common; pH 6.0; abrupt change

Layer 3 – B2 (0.30-0.60 m) Strong brown (7.5YR 5/8) medium clay with distinct grey and orange mottles (20-50%); weak pedality, 50-100 mm polyhedral peds with rough-faced fabric; moderately firm and plastic (moist) consistence; few plant roots; field pH 5.5; gradual change to

Layer 4 – R (0.60-1.50 m) weathered sandstone (coarse), bedrock reached, equipment refusal, end of test pit.

Test Pit 76 Landform: Upper slope (4%) southwest aspect
Soil classification: Brown Sodosol (Dy5.42)
Location: NE, near fence to common (320593E 6404801N)
Surface condition: firm, 100% groundcover, volun./native pasture

Layer 1 – A1 (0.0-0.30 m) Very dark greyish brown (10YR 3/2) light sandy clay loam; massive with earthy fabric; moderately weak and brittle (dry) consistence; many plant roots, field pH 6.0; clear boundary to

Layer 2 – A2 (0.30-0.40 m) Light yellowish brown (10YR 6/4) sandy loam; massive with earthy fabric; moderately weak and brittle (dry) consistence; very few sub-anular fine gravel; roots common; abrupt boundary to

Layer 3 – B2 (0.40-0.80 m) Yellowish brown (10YR 5/4) heavy clay with distinct orange and grey mottles; moderate pedality, 50-100 mm polyhedral peds; moderately strong (dry) consistence; few roots; field pH 7.5; gradual change to

Layer 4 – C (0.80-1.20 m) weathered sandstone (coarse).

Test Pit 77 Landform: Footslope (1%) westerly aspect
Soil classification: Brown Sodosol (Db4.43)
Location: North of house, past trees (319881E 6404469N)
Surface condition: firm, 90% groundcover, volun./native pasture

Layer 1 – A1 (0.0-0.15 m) Very dark greyish brown (10YR 3/2) fine sandy loam; massive with earthy fabric; moderately weak and brittle (dry) consistence; abundant roots; field pH 5.9; gradual change to

Layer 2 – A2 (0.15-0.20 m) Greyish brown (10YR 5/2) sandy loam; massive and earthy fabric; moderately weak and brittle (dry) consistence; many roots; field pH 6.5; abrupt boundary to

Layer 3 – B21 (0.20-0.60 m) Brown (7.5YR 4/4) light medium clay; strong pedality, polyhedral peds (50-100 mm) with rough-faced fabric; moderately firm and brittle (moist) consistence; plant roots common; field pH 8.1; gradual change to

Layer 4 – B22 (0.60-1.50 m) Yellowish brown (10YR 5/6) sandy clay loam; weak pedaity, with 5-10 mm polyhedral peds with earthy fabric; moderately firm and crumbly (moderately moist) consistence; sub-angular, sub-angular tabular and angular fine gravel and gravel common; few plant roots; field pH 8.3; gradual boundary to

Layer 5 – C (1.5-2.5 m) yellowish brown (10YR 5/8) light sandy clay loam with very few sub-angular, sub-angular tabular and angular fine gravel; field pH 8.6; end of excavation, soil continues.

Test Pit 78 Landform: Lower slope (3%) westerly aspect
Soil classification: Brown sodosol (Db1.32)
Location: west of the road (320025E 6404559)
Surface condition: hardest, 70% groundcover, volun/native pasture

Layer 1 – A (0.0-0.10 m) Dark greyish brown (10YR3/2) loam; weak pedality, 20-50 mm polyhedral peds with earthy fabric; moderately firm and brittle (dry) consistence; sub-rounded, sub-angular and sub-angular fine gravel and gravel common; many roots; field pH 5.5; (may include sporadic A2) abrupt boundary to

Layer 2 – B21 (0.10-0.60 m) Brown (10YR 4/3) light medium clay; moderate pedality, 20-50 mm sub-angular blocky peds with rough-faced fabric; moderately strong (dry) consistence; sub-rounded and sub-angular fine gravel common; few roots; field pH 7.0; diffuse boundary to

Layer 3 – B22 (0.60-1.20 m) Dark greyish brown (10YR 4/2) clay with abundant rounded, rounded tabular and sub-rounded fine-coarse gravel; diffuse change to

Layer 4 – C (1.20-2.0 m) abundant rounded, rounded tabular and sub-rounded fine-coarse gravel, equipment refusal, end to excavation.

Test Pit 79 Landform: Lower slope (6%) south westerly aspect
Soil classification: Grey Sodosol (Dy4)

Location: North west of site, (320008E 6404830N)
Surface condition: firm, 100% groundcover, volun./native pasture

Layer 1 – A1 (0.0-0.07) Very dark greyish brown (10YR 3/2) fine sandy clay loam; weak pedality, sub-angular blocky peds with earthy fabric, moderately weak and brittle (dry) consistence; very few sub-angular fine gravel, many roots; clear change to

Layer 2 – A2 (0.07-0.14 m) Greyish brown (10YR 5/2) fine sandy clay loam; massive with earthy fabric; very weak and brittle consistence; abundant sub-rounded and sub-angular fine and coarse gravel; roots common; abrupt change to

Layer 3 – B2 (0.14-0.83 m) Dark greyish brown (10YR 4/2) heavy clay; weak 50-100 polyhedral peds, rough-faced; firm and plastic (moist) consistence; few angular gravel; gradual change to

Layer 4 – C (0.83-13.0 m) weathered sandstone, end of excavation.

Test Pit 80 Landform: Midslope (6%) westerly
Soil classification: Grey Sodosol (Dy3.4)
Location: West of road, near yards (320096E 6404555N)
Surface condition: hardest, 80% groundcover, volun/native pasture

Layer 1 – A1 (0.0-0.08 m) Dark brown (10YR 3/3) clay loam; weak polyhedral peds (10-20 mm) with earthy fabric; very weak and brittle (dry) consistence; angular and angular tabular fine gravel and gravel common; many roots; abrupt change to

Layer 2 – A2 (0.08-0.16 m) Greyish brown (10YR 5/2) silt clay loam; massive with earthy fabric; sub-angular, angular and angular tabular fine and coarse gravel abundant; roots common, abrupt change to

Layer 3 – B21 (0.16-0.60 m) Greyish brown (2.5Y 5/2) heavy clay, weak pedality, 50-100 mm polyhedral rough-faced peds; moderately firm and plastic (moist) consistence; few roots; clear change to

Layer 4 – B22 (0.6-1.2 m) Yellowish red (5YR 4/6) medium clay; weak 50-100 mm polyhedral rough-faced peds; very firm and labile (moderately moist) consistence; clear boundary to

Layer 5 – C (1.2-1.5 m) red and white mottled siltstone, end of excavation.

Test Pit 81 Landform: Creek flat (alluvial)
Soil classification: Loamy Rudosol (UC5.1)
Location: adjacent to Creek; (319506E 6404492N)
Surface condition: soft, 100% groundcover, improved pasture

Layer 1 – A11 (0.0-0.20 m) Very dark greyish brown (10YR 3/2) sandy loam; massive, sandy fabric; very weak force and brittle (dry) consistence; many plant roots; gradual change to

Layer 2 – A12 (0.20-1.20 m) Dark brown (10YR 3/3) sandy loam; weak pedality, 50-100 mm sub-angular blocky peds, sandy fabric; very weak and brittle (dry) consistence; roots common; diffuse boundary to

Layer 3 – B21 (1.20-2.20 m) Dark brown (10YR 3/3) loamy sand; loose and single grained (dry); diffuse boundary to

Layer 4 – B22 (2.20-3.00 m) Brown (10YR 4/3) loamy sand; loose and single grained (dry); end of excavation, layer continues.

Test Pit 82 Landform: Footslope (1%) south west aspect
Soil classification: Grey Sodosol (Dy3.42)
Location: Paddock east of drainage line (319884E 6403698N)
Surface condition: hardest, 100% groundcover, volun./native pasture

Layer 1 – A1 (0.0-0.18 m) Brown (10YR 4/3) clay loam; massive with earthy fabric; moderately firm and brittle (dry) consistence; many roots; clear change

Layer 2 – A2 (0.18-0.22 m) Brown (10YR 5/3) clay loam; massive with earthy fabric; moderately weak and brittle (dry) consistence; roots common; clear change to

Layer 3 – B21 (0.22-0.62 m) Greyish brown (10YR 5/2) heavy clay; strong pedality, 50-100 mm prismatic and rough-faced peds; moderately strong; few roots; diffuse change to

Layer 4 – B22 (0.62-0.1.25 m) Dark greyish brown (10YR 4/4) light clay; massive with earthy fabric; moderately strong (dry) consistence; few roots; diffuse change

Layer 5 – B23 (1.25-2.20 m) Dark greyish brown (10YR 4/4) light medium clay; very firm and crumbly consistence; end of excavation, soil continues.

Test Pit 84 Landform: Midslope (6%) south westerly aspect
Soil classification: Brown Sodosol (Db3.33)
Location: Side of round hill (320186E 6404107N)
Surface condition: firm, 100% groundcover, volun./native pasture

Layer 1 – A (0.0-0.14 m) Very dark greyish brown (10YR 3/2) loam (sporadic bleach); weak pedality, 10-20 mm polyhedral peds, earthy fabric; moderately weak and brittle (dry) consistence; few sub-angular, sub-angular tabular and sub-angular platy fine gravel and gravel; abundant roots; field pH 5.5; abrupt change to

Layer 2 – B21 (0.14-0.40 m) Brown (10YR 4/3) light medium clay; strong pedality, prismatic and rough-faced peds (20-50 mm); moderately strong (dry) consistence; very few angular fine gravel; roots common; field pH 6.0; gradual change to

Layer 3 – B22 (0.4-0.8 m) Brown (10YR 5/3) light medium clay; weak pedality, 20-50 mm polyhedral peds: moderately firm and plastic (moist) consistence; few roots; field pH 8.5; clear boundary to

Layer 4 – C1 (0.8-1.5 m) orange and white mottled fine sandstone/siltstone diffuse change

Layer 5 – C2 (1.5-2.3 m) weathered mudstone, end of excavation.

Test Pit 85 Landform: Upper slope (8%) westerly aspect
Soil classification: Mottled-Sodic Red Chromosol (Dy5.12)
Location: Top of round hill (320325E 6404178N)
Surface condition: soft, 100% groundcover, volun./native pasture

Layer 1 – A (0.0-0.12 m) Dark yellowish brown (10YR 4/4) loam; moderate pedality, 20-50 mm polyhedral peds, earthy fabric; moderately weak and brittle (dry) consistence; many roots; abrupt change to

Layer 2 – B21 (0.12-0.42 m) Yellowish red (5YR 5/6) heavy clay; strong pedality, 20-50 mm polyhedral peds, rough-faced; moderately firm and crumbly (dry) consistence; roots few; field pH 7.5; clear change

Layer 3 – B22 (0.42-0.65 m) Yellowish brown (10YR 5/6) medium clay; moderate pedality, 20-50 mm polyhedral peds, rough-faced; very firm and crumbly (dry) consistence; gradual change to

Layer 4 – C (0.65-0.82 m) highly weathered layered fine sandstone

Layer 5 – R (0.82-1.60 m) siltstone with rounded structures, end of excavation.

Test Pit 88 Landform: Upper slope (7%) westerly aspect
Soil classification: Sodic Bleached-Mottled Brown Chromosol (Dy4.42)
Location: Eastern, timbered area (321280E 6403444N)
Surface condition: soft

Layer 1 – A1 (0.0-0.24) Dark greyish brown (10YR 4/2) sandy clay loam; massive peds, earthy fabric; very weak force and brittle (dry) consistence; few sub-angular fine gravel; field pH 5.5; clear change to

Layer 2 – A2 (0.24-0.38) Light brownish grey (10YR 6/2) bleached, light sandy clay loam; massive with earthy fabric, very weak force and brittle (dry) consistence; few sub-angular and angular fine gravel and gravel; manganiferous segregations; roots common; field pH 6.5; clear boundary to

Layer 3 – B2 (0.38-0.65) Yellowish brown (10YR 5/4) medium heavy clay; moderate pedality, 20-50 mm polyhedral and rough-faced peds; moderately firm and crumbly (moderately moist) consistence; few roots; field pH 7.0; clear change to

Layer 4 – R (0.65-1.0 m) bedrock reached, sandstone (coarse), equipment refusal, end of excavation.

Test Pit 89 Landform: Terrace
Soil classification: Brown Sodosol (Db1.12)
Location: Creek terrace, west of road and next to fence (319659E 6403676N)
Surface condition: poached

Layer 1 – A (0.0-0.45 m) Dark brown (10YR 3/3) loam; weak pedality, 100-200 mm polyhedral peds, sandy fabric; moderately weak and brittle (dry) consistence; field pH 6.9; abrupt change to

Layer 2 – B21 (0.45-0.9 m) Dark brown (7.5YR 3/4) medium clay; moderate pedality, 50-100 mm polyhedral peds; very firm and crumbly (dry) consistence; pH 7.6; diffuse change to

Layer 3 – B22 (0.9-1.2 m) Brown (7.5YR 4/4) clay loam; massive; very firm and crumbly (dry) consistence; pH 7.4; diffuse change to

Layer 4 – B23 (1.2-1.5 m) Brown (7.5YR 4/4) light clay; pH 7.1; diffuse change to

Layer 5 – C (1.5-2.5 m) Brown (7.5YR 4/3) fine sandy clay loam; pH 7.2; end of excavation, soil continues.

Test Pit 90 Landform: Midslope (5%) westerly aspect
Soil classification: Brown Sodosol (Dy2.13)
Location: South of site, above power lines (320066E 6403191N)
Surface condition: hardset, 90% groundcover, volun./native pasture

Layer 1 – A (0.0-0.15 m) Very dark brown (10YR 2.5/2) loam; weak pedality, 20-50 mm polyhedral peds; moderately weak and brittle (dry) consistence; many roots; field pH 6.5; abrupt change to

Layer 2 – B21 (0.15-0.3 m) Yellowish brown (10YR 5/4) heavy clay; moderate pedality, 50-100 mm prismatic and rough-faced peds; moderately strong (dry) consistence; roots common; pH 8.5; clear boundary to

Layer 3 – B22 (0.3-0.6 m) Dark yellowish brown (10YR 4/6) heavy clay; moderate pedality, 20-50 mm polyhedral and rough-faced peds; roots few; field pH 9.0 clear boundary to

Layer 4 – C (0.6-0.7 m) ironstone

Layer 5 – R (1.4) red and white fine sandstone/siltstone, end of excavation.

Appendix B – Soil test report SCO08/400

Department of Lands

Soil Conservation Service

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO08/400R1
REPORT TO:	Lisa Richards Ashton Coal Operation Pty Ltd South East Open Cut PO Box 699 Singleton NSW 2330
REPORT ON:	Seventeen soil samples
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	11 November 2008
METHODS:	Information on test procedures can be obtained from Scone Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED
THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

SR Young

SR Young
(Laboratory Manager)

Scone Research Centre, PO Box 283 Scone 2337, 709 Gundy Road Scone 2337
Ph: 02 6545 1666, Fax: 02 6545 2520

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO08/400R1
Client Reference: Lisa Richards
Ashton Coal Operation Pty Ltd
South East Open Cut
PO Box 699
Singleton NSW 2330

Lab No	Method	P7B/1 Particle Size Analysis (%)					P8A/2	P9B/2	C1A/4	C2A/3	C8B/1	
	Sample Id	clay	silt	f sand	c sand	gravel	D%	EAT	EC (dS/m)	pH	P sorp (mg/kg)	P sorp index
1	TP74/1 0-0.12 m	20	25	39	15	1	40	8/3(1)	0.03	5.7	151	1.5
2	TP74/2 0.12-0.40 m	55	20	20	5	<1	39	3(3)	0.12	5.6	312	2.5
3	TP79/1 0-0.07 m	12	15	34	29	10	21	8/3(1)	0.04	5.6	nt	nt
4	TP79/3 0.14-0.83 m	39	13	18	24	6	83	2(2)	0.45	8.4	nt	nt
5	TP80/1 0-0.08 m	15	14	31	18	22	19	8/3(1)	0.04	6.0	nt	nt
6	TP80/3 0.16-0.60 m	55	15	18	10	2	62	2(1)	0.35	7.6	nt	nt
7	TP80/4 0.60-1.20 m	53	16	24	7	0	84	2(3)	0.64	5.6	nt	nt
8	TP81/1 0-0.20 m	14	12	62	12	0	11	3(1)	0.02	6.3	nt	nt
9	TP81/2 0.20-1.20 m	15	12	49	24	0	48	3(2)	0.05	7.3	nt	nt
10	TP81/3 1.20-2.20 m	10	3	31	56	<1	45	3(2)	0.10	7.0	nt	nt

nt = not tested

SR Young

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO08/400R1
Client Reference: Lisa Richards
Ashton Coal Operation Pty Ltd
South East Open Cut
PO Box 699
Singleton NSW 2330

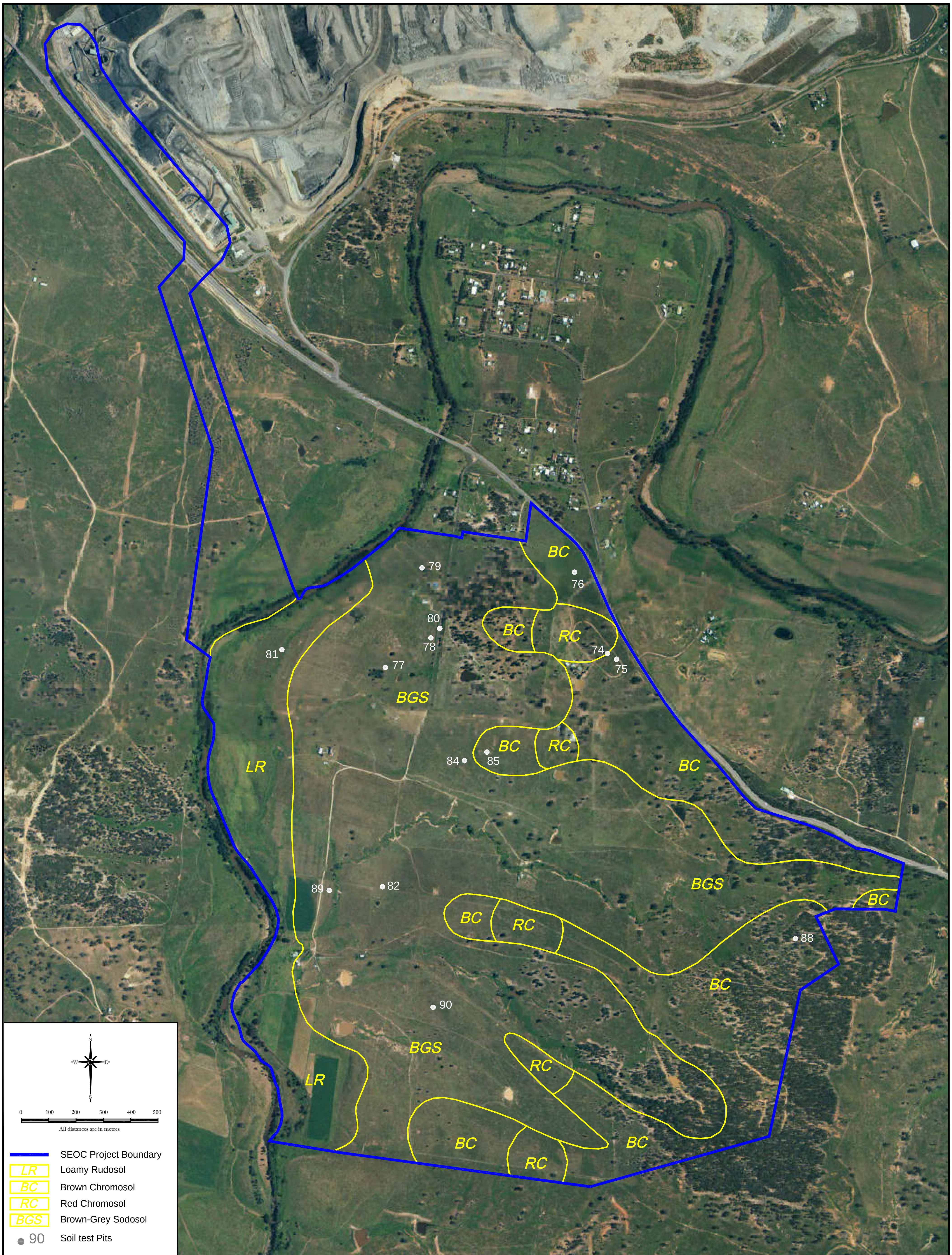
Lab No	Method	P7B/1 Particle Size Analysis (%)					P8A/2	P9B/2	C1A/4	C2A/3	C8B/1	
	Sample Id	clay	silt	f sand	c sand	gravel	D%	EAT	EC (dS/m)	pH	P sorp (mg/kg)	P sorp index
11	TP88/1 0-0.24 m	14	14	28	43	1	15	3(1)	<0.01	5.9	139	1.4
12	TP88/3 0.38-0.65 m	35	12	16	37	<1	55	3(2)	0.03	6.8	248	2.0
13	TP89/1 0-0.45 m	17	27	53	3	0	31	3(1)	0.04	6.9	nt	nt
14	TP89/2 0.45-0.90 m	41	14	40	5	0	52	2(1)	0.10	7.6	nt	nt
15	TP89/5 1.50-2.50 m	26	20	49	5	0	71	2(2)	0.19	7.2	nt	nt
16	TP90/1 0-0.15 m	20	14	49	10	7	18	8/3(1)	0.02	6.3	nt	nt
17	TP90/3 0.30-0.60 m	56	9	26	8	1	25	2(1)	0.19	8.6	nt	nt

nt = not tested

SR Young

END OF TEST REPORT

Appendix C – Soil, land capability, agricultural suitability and topdressing material maps



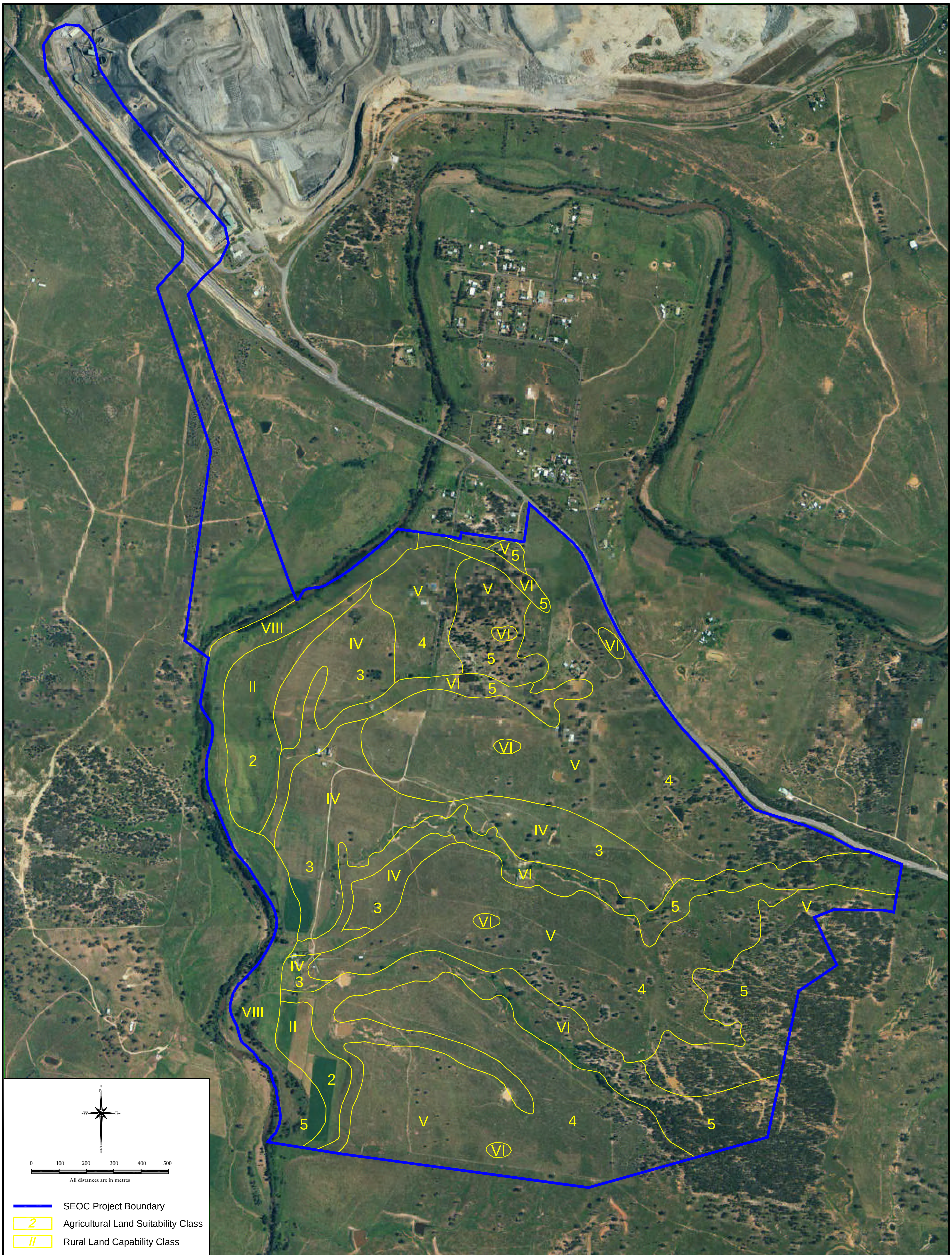
AshtonCoal

South East Open Cut Project

Soil Type Boundaries

Prepared by Pegasus Technical

CAD FILE: 05056A.dwg



South East Open Cut Project

Land Capability and Agricultural Suitability

Prepared by Pegasus Technical

CAD FILE: 05057A.dwg